

DOCUMENT RESUME

ED 261 543

FL 015 211

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TITLE Tracing Developmental Change in Language Comprehension Ability Before Twelve Months of Age.
INSTITUTION Stanford Univ., Calif. Dept. of Linguistics.
PUB DATE Aug 85
NOTE 9p.; Papers and Reports on Child Language Development, Volume 24, p87-94, Aug 1985. For related documents, see FL 202-210 and 212-17.
PUB TYPE Reports - Research/Technical (143)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Child Language; Developmental Stages; *Infants; Intellectual Development; *Language Acquisition; *Listening Comprehension; *Receptive Language; *Recognition (Psychology); Vocabulary Development
IDENTIFIERS *Referents (Linguistics)

ABSTRACT

A study of children's recognitory comprehension, the rudimentary ability to begin decoding the content of language, at the end of the first year had as subjects 36 infants aged 10.5, 11.5, and 12.5 months. In an examination of monthly developmental change in their ability to comprehend newly introduced referential terms, the children were exposed to toys, displayed under lights and available for manipulation, as well as the toys' names. Target questions about the toy and control questions using nonsense words were asked of the children. The process was videotaped. The proportion of time the child fixated the target toy out of the total time spent fixating all the toys was calculated for the question intervals. The infants were able to recognize the referent of an object name after a brief, naturalistic language exposure. This ability probably constitutes the beginning of the capacity to learn the conventionalized referential meaning of language. The findings suggest that this age range, although small, represents a period of rapid development of lexical recognition. The findings are consistent with cognitive theories of intellectual development. (MSE)

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Tracing Developmental Change in Language Comprehension Ability Before Twelve Months of Age

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Infants acquire an extensive understanding of language well before language production ever gathers momentum. During this early receptive period, the emergence of certain processing abilities appears to fuel the active process of language acquisition. Previous experimental work has shown that recognitory comprehension ability, which enables infants to begin responding appropriately to object and action names, can be demonstrated in some cases as early as 10.5 months of age (Oviatt, 1980). However, a sensitive analysis of the consolidation of this skill has not been performed. Following the emergence of this ability to begin decoding the content of speech, specific advances in infants' understanding of language as a flexible, symbolic system have been identified. For example, between approximately 1 and 1.5 years of age infants' ability to comprehend language referring to out-of-view objects and categorically-related groups of objects develops, greatly expanding the scope and efficiency of their receptive language (Huttenlocher, 1974; Katz, Baker and Macnamara, 1974; Oviatt, 1982). This report summarizes some preliminary research results on the emergence of infants' recognitory comprehension ability toward the end of the first year.

What is recognitory comprehension? Recognitory comprehension is a rudimentary language comprehension ability that enables infants to begin decoding the content of language. It presupposes: (1) that infants perceive a distinctive word-level pattern within the speech stream, (2) that they recognize this speech pattern as familiar since they have associated it previously with some significant regularity in the environment, such as an object or action pattern, (3) that this recognition promptly cues infants' recollection of the appropriate object or action, and (4) that this recollection then directs their attention toward the indicated object or event. Furthermore, recognitory comprehension entails (5) infants' acknowledgement at a social/communicative level of the speaker, which is evident from gaze as well as affective and vocal expressions directed toward the speaker during questioning, and in a manner that is temporally interspersed with directing gaze and other activity at the referent, as well as (6) infants' recognition of certain pragmatic elements posed by the speaker's utterance within the given communicative situation which serve to constrain the infant's "task" (e.g., general recognition of the "Where's the X?" question frame). All of the above are evident in infants who demonstrate recognitory comprehension, although infants who do not yet show evidence of comprehending a particular word may nonetheless be capable of some subset of the above, such as 1, 5, or 6. The actual order of developmental emergence of these related skills within language decoding tasks has not been investigated. By contrast, it is not assumed that explicit metalinguistic knowledge of the designative force of language is present when recognitory comprehension ability first emerges, nor is it assumed that infants' understanding of language is symbolic in the sense of recognizing names for categorically-related objects and events or for objects displaced in time and space.

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When infants first begin responding reliably and appropriately to certain recognized words, two substantial changes occur in their behavior. First, they begin to distribute their attention to objects and events in the world very differently. That is, as language becomes understood, infants' attention is automatically and forcefully redirected to named referents. This directive power of language to channel attention and activity is perhaps even more impressive in young infants than it is in adults. Second, a reorganization is evident in infants' social interactions with others in the family. Parents are certainly sensitive to their infants' dawning language ability, as witnessed by the impressive impact that it begins to have on their activity, and they capitalize on this new skill in a variety of situations. The change in parent-infant interaction is evident in parents' increased use of language to engage and constrain infants' activity during playful social exchanges, teaching activities such as joint book reading, and daily caregiving routines that require compliance.

Research Objective and Methodological Rationale. The goal of the present research was to examine monthly developmental change in infants' ability to comprehend newly-introduced referential terms between 10 and 12 months of age. In order to permit a sensitive analysis of the consolidation of this skill, a method was devised that emphasizes optimal language training and measurement sensitivity. Infants were taught new object names so that their processing ability could be evaluated "in action," and independently of repertoire size. Infants' actual receptive repertoires vary a great deal depending on language exposure, and can be estimated only roughly from maternal reports which tend to be variable and prone to a liberal bias (Nelson, 1973; Snow, 1979). The language training used in this study was modelled after naturalistic interactions (*c.f.* Snow, 1972), engaged mothers' assistance, and used novel mechanical toys that moved, made distinctive sounds, and were highly engaging of young infants' interest.

To enhance measurement sensitivity, the devised method incorporated two powerful and widely used techniques: the paired-comparison test format, using gaze as a dependent measure (Maurer, 1975), and a signal detection analytical framework for estimating the probability that infants correctly detected signals from noise (Green & Swets, 1966). During testing, infants were asked target and control questions while viewing a pair of target and distractor toys. The percentage of time that infants spent fixating each alternative was recorded on split-screen videotapes and analyzed for target and false positive responding. Control questions were included to rule out response biases and contextual cues as a basis for responding. The simple paired-comparison test format was designed to minimize distraction and reduce memory load so that recognition of specific words would be discernible within this supportive training and testing context at the point when it was first beginning to emerge. That is, an effort was made to promote infants' optimal level of performance so that any shift in their capacity could be detected (Fischer & Bullock, 1981; Fischer & Pipp, 1984). Gaze has been recognized to provide a sensitive index of language comprehension in previous studies (Cooper, 1975; Oviatt, 1980 & 1982), and was selected for this study because spontaneous pointing is not generally available in infants' repertoires before 12 months of age. Finally, recent work has demonstrated that the logic of signal detection can be applied to the analysis of infant language comprehension (Oviatt, 1980; Thomas, Campos, Shucard, Ramsay,

& Shucard, 1981).

Summary of the Experiment. Thirty-six infants were tested, 12 each at 10.5, 11.5, and 12.5 months of age. Half of the infants in each age group were male and half were female. When an infant arrived, he or she played with toys during a 10 minute warm-up period, while the parent was interviewed and given instructions. During interviewing, it was established that the infant was familiar with the "Where's the X?" question frame, as indicated by successful search for two in-view objects. Infants were screened to insure that they were not familiar with the mechanical toy selected for training, or with its name. Subsequently, half of the infants were trained with the robot and half with the witch, using the two-syllable names "robot" and "witchie."

After these preliminaries, the infant was seated in a testing apparatus that included a 5' x 5' carpeted base, with two display boxes and video equipment located at one end, and seating for an infant and two adults located at the other end. Each display box was painted black on the inside, with a row of small incandescent lights along the top, and a smoked plexiglas front surface. The contents of the boxes were clearly visible with the lights on, although the plexiglas surface was opaque with the lights off. The two display boxes were arranged side by side, approximately 3' in front of the infant seat and displaced by 30°. A video camera, equipped with zoom lens and low light level capacity, was located directly above the center of each box. The cameras were adjusted to record a close-up image of the top half of the infant from both angles, and these recordings then were fed through a special effects generator to create a single split-screen videotape for analysis. A large black curtain, with openings to accommodate the display boxes and camera lenses, completely concealed the video equipment located behind. A hanging lamp illuminated the area around the infant at a level bright enough to permit videotaping without overhead lights, while still dim enough for the display boxes to operate effectively on a relative light principle.

Two colorful mechanical toys that moved and emitted distinctive noises were used for testing. One toy was a witch that hopped forward on a broomstick when operated, and the second toy was a robot that rolled forward and displayed an illuminated moving picture on its chest. Both toys were adapted to plug into a constant power source at the back of the display boxes, and could be moved in and out of the boxes through side doors. A control panel located next to the experimenter's seat was used to operate the toys and lights at appropriate points in the procedure.

The infant actually sat in an upright car seat that was elevated 10" and faced the two display boxes. The parent and experimenter were seated on pillows on either side of the infant. As the procedure began, the experimenter flashed the display box lights and said, "Oh look (baby's name)," and then left the lights on for 20 seconds of silence while the infant examined the toy witch and robot. Then, the toy selected for training was placed in front of the infant on a small table. While the infant explored and handled the toy, the mother and experimenter spent two minutes jointly teaching the infant its name. Both adults repeated the name alone and in short phrases, using typically stylized adult speech to infants and indicating the toy (e.g., "robot...see the robot?(pointing)...robot...there goes robot(pointing)"). This naturalistic training method has been detailed elsewhere (Oviatt, 1980). After training, the infant was distracted with novel toys while the training toy was returned to the display box. Once again, the infant was shown the two toys inside the display boxes during 20 seconds of si-

lence. This was followed by two more 20-second intervals during which the adults asked target questions (e.g., "Where's the robot?") and nonsense control questions (e.g., "Where's the kawlow?"), the order of which was counterbalanced across subjects. During both question intervals, the experimenter flashed the display lights to focus the infant's attention on the toys, and then touched and called the infant in order to make eye contact before asking the target or control question three times in succession. Afterwards, the parent solicited their infant's attention and repeated the same question three more times. The parent was instructed to continue looking at the infant throughout questioning, and not to look or gesture at either display box. Nonsense words were always two syllables, with no phonemes in common with the training name. No reinforcement was given to the infant for responding to questions.

To summarize, the procedure progressed through silent viewing, naturalistic training, silent viewing, and target and control questioning (counterbalanced). Both the order of target and control questioning and the target toy location in the left or right display box were counterbalanced. The procedure took 6 to 8 minutes, and was videotaped.

The videotapes were scored for the total number of seconds that each infant fixated the target and distractor toys during target and control question intervals. From these data, the proportion of time that each infant fixated the target toy out of the total time spent fixating the target and distractor toys was calculated for both question intervals. A language comprehension index was computed for each infant by subtracting the proportion of time spent fixating the target toy during nonsense questioning from the proportion of time spent fixating the target toy during target questioning.

An electronic timer with .01 sec accuracy was used to accumulate fixation times for the scored intervals, with totals rounded to the nearest .5 sec. Each interval was scored twice, and measurements departing by 1 sec or more were resolved by taking a third score. An independent observer second scored 25% of the data for a random selection of subjects distributed across age and sex groups. The percentage agreement between the two scorers, calculated as the number of timed intervals that agreed to within .5 sec out of all those scored, was .95. Videotape scoring was conducted blind to the location of the target toy during testing.

For each infant, the following two indices of general attentiveness were scored: 1) the proportion of the total training interval that the infant fixated the training toy, and 2) the proportion of the total time during target and control questioning that the infant fixated the two displayed toys. Data were to be discarded for any infant whose percentage dropped below 50% on the first measure, or below 20% during either question interval on the second measure.

Evidence for Emerging Language Comprehension. The language comprehension index (LCI) ranged from low negative values to over +30 for all infants studied, with negative and low positive values indicating a lack of lexical recognition, and moderate to high positive values demonstrating recognition of the appropriate word-referent link. As a group, 10-to-12-month-old infants looked longer at the target toy than the distractor during target questioning. By contrast, time spent looking at the target and distractor toys was comparable during control questioning, indicating no overall tendency to false alarm. Analysis of variance indicated no significant difference in performance as a function of the training toy used, or its location in the left versus right

display box during testing. However, infants' LCIs did vary significantly as a function of age in months and sex, and an age x sex interaction was apparent. Follow-up tests revealed that females' LCIs increased significantly between 10 and 11 months of age, but made no further improvement between 11 and 12 months. By contrast, males' LCIs did not increase significantly between 10 and 11 months, but did increase significantly between 11 and 12 months of age. Females' comprehension was advanced significantly beyond that of males only at the 11-month age level.

Infants' attention during various phases of the experimental procedure was uniformly high, with no apparent difference in interest or ability to attend to the task as a function of age or sex. The average percentage of the total training interval spent fixating the training toy was comparable for the three age groups, as well as for males and females, and ranged over 75% for all groups. There was likewise no significant difference among these groups in attentiveness to the toys during questioning. The average percentage of time spent fixating the display toys during target and control questioning was comparable for all groups, and consistently ranged over 50%.

General Discussion. The research presented demonstrates that infants under 12 months of age are able to recognize the referent of an object name after a brief, naturalistic language exposure. This constitutes the beginning of infants' ability to learn the conventionalized referential meaning of language. Using the present method, it was possible to trace the abrupt consolidation of recognitory comprehension ability within the brief 2-month span between 10 and 12 months. At 10 months of age, 8 of 12 infants scored $< +8.5$, within a range indicating no clear lexical recognition. By 12 months of age, 8 of 12 infants scored $\geq +16.5$, at a level demonstrating clear recognition of the appropriate word—referent link. These results emphasize the striking degree of stability among infants in the acquisition of recognitory comprehension ability, especially by comparison with the variability evident in the onset of the language production system.

During this period of rapid development, performance of males and females was comparable at the boundary ages of 10 and 12 months, although females' performance surpassed that of males at the 11-month age level. Closer examination reveals that females' ability to comprehend the object names mushroomed between 10 and 11 months, while males' performance showed a parallel increase one month later. That is, language comprehension ability consolidated earlier for females, however the overall difference in skill level between the sexes was a modest, transitional one. There was no indication that motivational or attentional factors contributed to this pattern of age and sex differences. In the past, research frequently has reported a female advantage in language production, but sex differences have usually been attributed to stylistic and fluency factors (Maccoby & Jacklin, 1974; Nelson & Bonvillian, 1973). These data are the first indication that the ability to comprehend language also differs for the sexes, affording females an initial advantage that appears to be based on processing capacity.

Why and how infants are able to begin comprehending language during the ages indicated remains obscure. It is assumed that infants who cannot comprehend the content of a linguistic utterance nonetheless recognize many of the social, pragmatic and other contextual constraints that govern communications more generally (Bates, Camaioni, & Volterra, 1973; Bruner, 1975; Clark, 1973; Murphy, 1978; Tronick, Als, & Adamson, 1977). Indeed, infants' sensitivity to affective, gestural, and acoustic cues from the speaker within a specific physical context in which the pragmatic force of

an utterance is recognized, and in which the social exchange and desire to please the adult are primary, may strongly motivate and constrain initial efforts to begin decoding speech. In order to fully appreciate how infants make this transition into language comprehension, it will be necessary to explore this collection of factors in more detail as they operate in particular instances. It will also be necessary to understand more about the development of infants' ability to recognize various pragmatic elements of an utterance, especially for ritualized prompts that adults use most frequently in addressing young infants. For example, the infant who does not understand "robot" but who recognizes "Where's the X?" as a question frame may realize that a response is required, that X pertains to an object, that the success conditions require indicating/offering the desired object, and that certain classes of feedback from the speaker (e.g., negative affect or repetition of the original question following a response) indicate that the success conditions have not been met and that another object should be selected. If infants first learn these general pragmatic principles that govern the task and their role within it for commonly used questions and commands, then this partial knowledge itself may create a dynamic tension to resolve the specific content of an utterance. This partial knowledge, then, may both motivate and constrain their decoding based on specific speaker and contextual cues, enabling them to meet the success conditions posed by their interaction partner. Infants' success at both a social and cognitive level must be a considerable source of mastery pleasure. However, to date we know very little regarding what infants do and do not know at a pragmatic level that may assist them in discerning their task, in decoding the content of a message, or in verifying whether they have in fact met the success conditions implicit in a particular communicative exchange.

The rapid consolidation of recognitory comprehension ability observed in this study is consistent with cognitive theories that describe the development of intellectual functioning during infancy as being depicted by a series of qualitative transitions (Fischer, 1980; McCall, Eichorn & Hogarty, 1977; Piaget, 1952). However, identification of the specific intellectual abilities that facilitate changes during language development are still not well understood. The emergence of recognitory comprehension may be precipitated in part by a cognitive transition that has been identified by Zelazo and colleagues (1980; 1983) in infants' capacity to begin "generating specific associations" just before one year of age, which appears to permeate a variety of cognitive and social behaviors. For example, infants begin engaging spontaneously in functional play with objects, such as using a hairbrush appropriately to brush one's hair, at about this age. While functional play entails recognizing an object, recollecting its specific adult-defined function, and then engaging in that activity, recognitory comprehension requires the parallel abilities of recognizing a word, recollecting its specific conventionalized referent, and then directing attention or activity toward that referent (see criteria 2-4 under *What is recognitory comprehension?*). The difference is that recognitory comprehension occurs within the context of a communicative interaction in which the infant acknowledges the speaker and engages in a comprehension "task." On a much more general level, it is believed that stage 5 sensorimotor behaviors are correlated with the earliest language abilities (Bates, 1979; Ingram, 1978). However, global examination of the correlations between sensorimotor behavior and language production is insufficient for understanding the transition to language. Along with applications from cognitive and speech act theory, research should provide more detailed conceptual analyses of specific language advances, and a more serious consideration of the comprehension abilities that interface nonlinguistic

cognition and language production. Pursuits of this kind may require a method similar to the one introduced in this research, with adequate sensitivity for tracing fine-grained change in language comprehension as it unfolds.

Acknowledgements

The author is grateful for support received from National Institute of Mental Health postdoctoral traineeship MH 15128, National Science Foundation grant 76 18244 to the Neural and Behavioral Biology Program, Psychology Department, University of Illinois, and U.S. Public Health Service grant HD 05951 to Joseph Campione and Ann Brown. Special thanks to Joseph Campione and Ann Brown for the use of their video laboratory, to Chieko Murasugi for assistance with data collection and scoring, and to Phil Cohen and Lois Bloom for helpful discussion during manuscript preparation.

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